

Centrorhynchidae (Acanthocephala) including the description of new species of *Centrorhynchus* from birds from the Côte d'Ivoire, Africa.

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Centrorhynchidae (Acanthocephala) including the description of new species of *Centrorhynchus* from birds from the Côte d'Ivoire, Africa. - Centrorhynchidae, including *Centrorhynchus chabaudi*, Golvan, 1958, and two new species *C. mariauxi* and *C. halcyonicola* are reported from the Côte d'Ivoire, for the first time. The new species are distinguished from congeners by a combination of proboscis armature and the morphometrics of the male reproductive system.

Keywords: Parasite - Acanthocephala - *Centrorhynchus* - Africa - Côte d'Ivoire - birds - *Accipiter* - *Halcyon* - *Kaupifalco*.

INTRODUCTION

The Centrorhynchidae (Palaeacanthocephala) is a cosmopolitan family occurring in birds and mammals and comprising three genera; *Centrorhynchus* Van Cleave, 1916, usually found in raptores, *Sphaerirostris* Golvan, 1956, usually found in passerines (Corvidae and Turdidae) and *Neolacunisoma* Amin & Canaris, 1997 found in shorebirds (Golvan, 1956, 1960, 1994; Amin & Canaris, 1997). *Centrorhynchus* is a large genus of about 90 known species (Golvan, 1994, Richardson & Nickol, 1995; Khan *et al.*, 2001, 2002a; Bhattacharya, 2003; Bilqees & Khan, 2005; Ghazi *et al.*, 2005; Lunaschi & Drago, 2010). The exact number of valid species in the genus is difficult to determine because the literature is confounded by many synonymies and misidentifications, some yet to be resolved. The species of *Centrorhynchus* described by Khan *et al.* (2002b) from a house crow, for example, may on further examination be found to belong in the genus *Sphaerirostris*. Eleven species, including *Centrorhynchus chabaudi* Golvan, 1958, *C. gendrei*, Golvan, 1957, *C. globocaudatus* (Zeder, 1800) and *C. milvus* Ward, 1956 from West Africa, have been reported from the African continent (Ward, 1956; Golvan, 1957, 1958; Dimitrova & Gibson, 2005). No centrorhynchids have been reported as yet from the Republic of the Côte d'Ivoire.

Between 1985 and 1988, during the course of a Ph D project of Dr J. Mariaux to study the cestode parasites of the birds of the Republic of Côte d'Ivoire, an incidental collection of Acanthocephala from 22 species representing 15 families of birds was made. Within this collection three bird species were infected, one with *C. chabaudi* and two with new species of *Centrorhynchus*. In this paper a redescription of *C. chabaudi*, with new host records and geographic locations documented, is given and the new species of *Centrorhynchus* are described.

MATERIALS AND METHODS

The birds examined included 8 individuals of 3 species from 2 families. The collection localities of hosts from which *Centrorhynchus* spp. were dissected, with the number of hosts examined in parentheses were as follows:

Halcyon malimbica forbesi (Shaw, 1811) from Korhogo 9° 27'N 4°03'W and Lamto Research Station 6° 13'N 5°00'W (5);

Kaupifalco m. monogrammicus (Temminck, 1824) from Lamto 6° 13'N 5°00'W (2);

Accipiter badius sphenuris Gmelin, 1788 from Lamto 6° 13'N 5° 00'W (1).

On dissection all specimens were fixed with neutral buffered 4% formalin and stored in 75% ethanol. Before microscopic examination all specimens were cleared in lactophenol or beechwood creosote to be studied as wet mounts. All measurements were taken using an eyepiece micrometer and are given in micrometers unless otherwise stated. Figures were drawn with the aid of a drawing tube.

Golvan's (1994) review of the Acanthocephala has been used as the foundation source for listing the valid species of *Centrorhynchus* supplemented by information from all the more recent publications. All specimens collected for this study are registered in the Muséum d'Histoire Naturelle, Geneva, Switzerland (MHNG).

RESULTS

The three species of *Centrorhynchus* found are given in Table 1. These all represent new host and locality records. Comparative measurements of all the species of *Centrorhynchus* known to occur in West Africa are given in Table 2.

TABLE 1. Acanthocephala from three bird hosts from the Republic of Côte d'Ivoire, West Africa, collected between 9.02.1987 and 13.02.1987.

Host	Host field no.	Locality	Centrorhynchidae
Accipitridae			
<i>Accipiter badius</i>	CI 618	Lamto	<i>Centrorhynchus chabaudi</i>
<i>Kaupifalco monogrammicus</i>	CI 586	Lamto	<i>Centrorhynchus mariauxi</i>
Alcedinidae			
<i>Halcyon malimbica</i>	CI 625	Lamto	<i>Centrorhynchus halcyonicola</i>
	CI 519	Korhogo	<i>Centrorhynchus halcyonicola</i>

TABLE II Comparative measurements of *Centrorhynchus* spp. from West Africa; data from Dimitrova

	<i>C. chaubadi</i>		<i>C. gendrei</i>		<i>C. globocaudatus</i>
	male	female	male	female	male
Trunk length mm	22	48	46	84	22
Neck length	150	450	-	-	500
Proboscis length	884	1350	800	1300	1030
rows hooks	30-34		38-40		30-32
hooks per row	17-23		34-40		20-21
true hooks thorn length	55-96		38-84		45-67.5
Proboscis receptacle length	2250	2200	1500		1400
Lemnisci length	2900	3400	2000-2500		2100
Testes	935x425		350x 160		820x440
	1020x408		400x120		900x450
Cement glands mm	11.4		29		12.6
Genital apparatus female, length		2000		2000	
Egg		60x23		30-35x20-22	

Centrorhynchus chabaudi Golvan, 1958

Figs 1-4

MATERIAL EXAMINED: One male, one immature female from *Accipiter badius* Gmelin, 1788, small intestine; Côte d'Ivoire, Lamto, 12.02.1987, J. Mariaux (MNHG INVE 38488).

DESCRIPTION

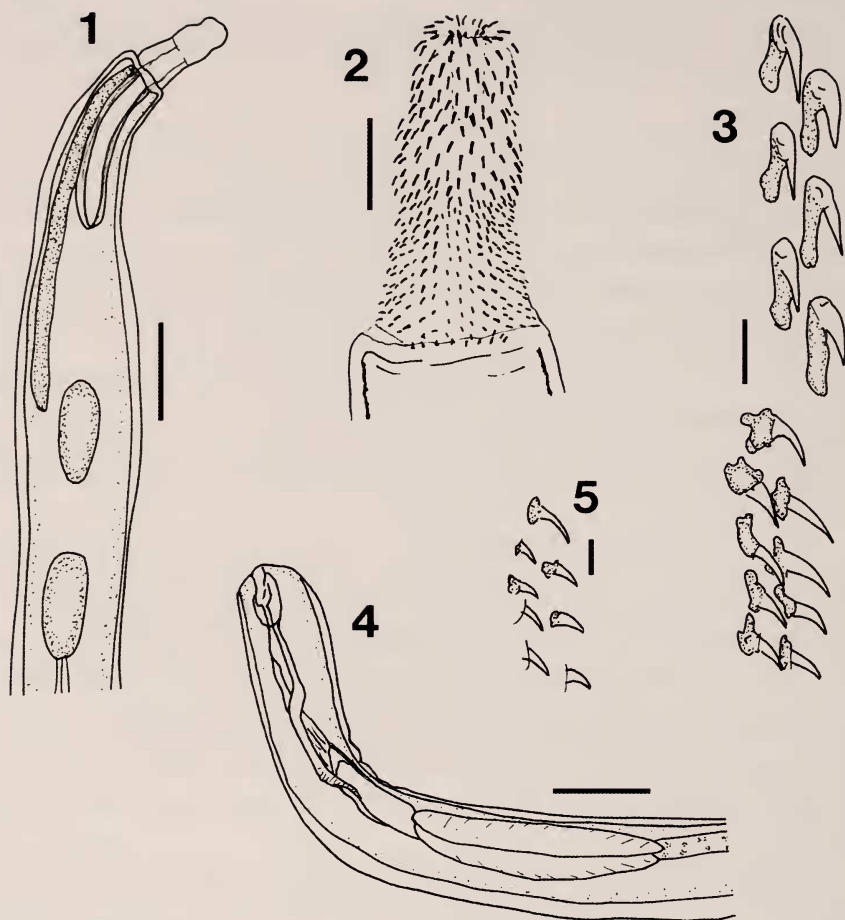
General: Trunk spineless, elongate, sub cylindrical, dilated anteriorly in region of lemnisci and proboscis receptacle. Proboscis in 2 parts, widest anterior to constriction, constriction at insertion of proboscis receptacle about 55-63% of distance from apex to proboscis base. Proboscis armed with 30-34 rows 15-22 hooks and spines. Anterior 4-5 hooks with large simple roots, next 5-6 hooks transitional with short roots with luniform- crescentic manubria, next 6-11 hooks spiniform, inserted on posterior part of proboscis, the more anterior of these with small, roughly triangular shaped roots. Neck spineless, well defined, shorter than broad. Proboscis receptacle double walled. Lemnisci tubular, inserted at base of neck, extend posteriorly beyond proboscis receptacle. Cerebral ganglion located at mid region of proboscis receptacle, just posterior to neck. Principal canals of lacunar system lateral, connected by transverse anastomoses.

Male: based on one specimen. Trunk 22 mm long, 1200 at widest part. Proboscis total length 884, greatest width 340, just anterior to constriction; posterior part 374 long. Hooks I-V thorns 55-80 long, hooks V-XI thorns 40-50 long, spines X-XXII 20-40 long. Neck 150 long, 374 wide at base. Proboscis receptacle 2250 long, 350 wide; lemnisci 2900 long. Testes oval, tandem, not contiguous, 0.5mm apart; anterior testis, 3.06 mm from anterior end of trunk, 935 long, 425 wide; posterior testis 1020 long, 408 wide. Cement glands elongate, tubular, begin immediately posterior to posterior testis, 11.4 mm long; number not determined; cement ducts elongated, 2805 long; Saeftigen's pouch and retracted bursa 2210 long; entire male system occupying about 86% trunk length.

Female: based on 1 immature female. Trunk 15 mm long, dilated anterior portion 3060 long, 510 wide, main trunk 255 wide. Proboscis partially inverted about 910 long, greatest width 400, just anterior to constriction; posterior part 370 long.

et al., 1995, Golvan, 1956, 1957, 1958; Ward, 1956; Dimitrova & Gibson, 2005; and this study.

<i>C. milvus</i>		<i>C. mariaux</i>		<i>C. halcyonicola</i>	
female	male	female	male	female	male
20-21	12-20	24-48	25	70+	20
600-800	150	-	300	-	-
1110-1130	800-1000	1100-1200	605	780	640
36-38	28-38		34-36		38-40
18	18-26		15-19		14-17
41-60	35-50		20-25.5		40-45
1100-1200	1300-1350	1600	1360	1400-2200	1370
	1800	2800	1273	1615	1530
	800x300		525x268		40x340
	1100x500		556x275		510x290
	5-10		17.5		14
2440		1000		2000	
		45-50x20-24		45x22	



FIGS 1-5

Centrorhynchus chabaudi Golvan, 1958. (1) Male anterior end. (2) Male proboscis showing armature. (3) Male anterior and transitional hooks. (4) Male posterior end. (5) Male spiniform hooks. Scale bars: 1, 4, 750 μ m; 2, 200 μ m; 3, 50 μ m; 5, 10 μ m.

Hooks V-VII 30-40 long, spines 20-26. Neck 135 long by 400 wide. Proboscis receptacle 1020 long, 205 wide; lemnisci 3400 long. Genital apparatus not observed, no mature eggs seen. Genital pore sub terminal.

COMMENTS: *Centrorhynchus chabaudi* was described by Golvan (1958) from two female worms up to 48mm long, main trunk 1000 wide, with a proboscis armature of 30-34 longitudinal rows of 15-16 hooks. The proboscis was 1350 long and 650 wide just anterior to the constriction and 700 wide at the base, with the neck 850 long by 450 wide. Hooks I-V thorns 55-96 long, hooks VI-X thorns 57-67 long, spines XVI 36 long. Neck 450 long, 850 wide at base. The proboscis receptacle was 2200 long by 400

wide and the lemnisci about 2000 long. Golvan (1958) also described the female genital apparatus (uterine bell to genital pore, 2000 long, genital pore sub terminal, at base of distinct terminal digitiform process) and eggs (oval, external shell thickened, sculptured with longitudinal ridges and grooves, 60 long, 23 wide).

The type host *Gyps africanus* (Salvadore, 1865) was given as *Pseudogyps africanus*, the white backed vulture, collected from Nioro du Sahel in 'the Sudan.' This locality is a town in the Kayes Region of the Republic of Mali bordering on the Côte d'Ivoire to the south. There have been no further records of *C. chabaudi* since then.

The two specimens, both the male and the immature female, from *A. badius* from Lamto in the Côte d'Ivoire conformed to the description given by Golvan (1958) as to general body shape and the proportions of the proboscis and lemnisci and in particular to the proportions and shapes of the proboscis hooks and spines. The proboscis armature varied only in the number of spines in each row. The number of spines on the specimens examined by Golvan (1958) is not clear. He describes the proboscis armature as having a total of 15 or 16 hooks, which would give 6-7 spines per row. In his figure 4, however, a total of 17 hooks is shown. This would suggest 6-8 spines for the specimens from Nioro du Sahel compared with the 10-11 spines for the specimens from Lamto. This variation in number of spines can be accommodated as either individual variation (only four worms having been examined in total) or perhaps host induced variation. The finding of a male specimen of *C. chabaudi* has enabled the preparation of a more complete description of the species. The number of cement glands, however, three or four, could not be determined from the whole mount of the male and there was no other specimen that could be dissected to confirm the number.

Centrorhynchus mariauxi sp. n.

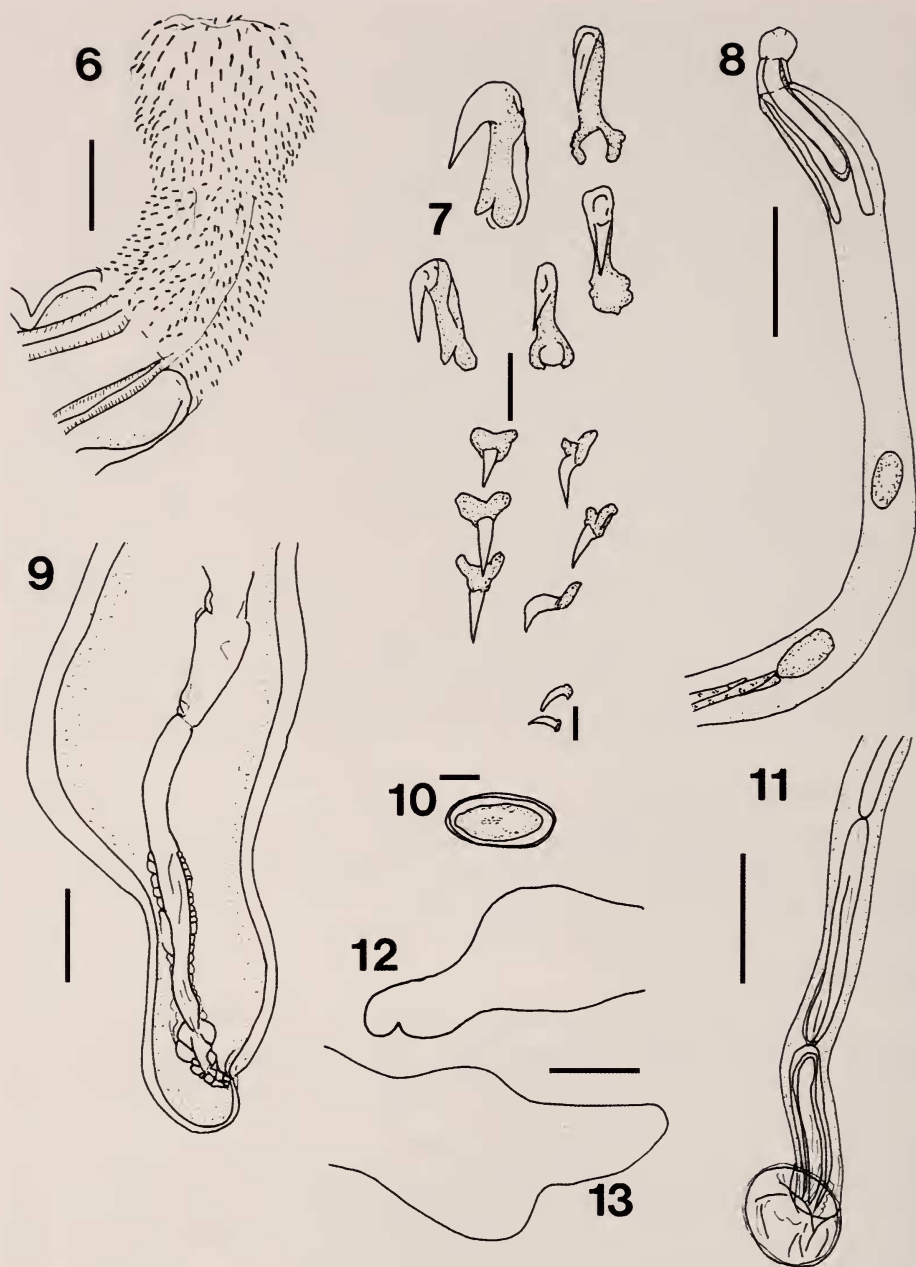
Figs 5-13

MATERIAL EXAMINED: Holotype male, paratypes, 8 pieces males, 2 females without proboscis, 4 pieces females from *Kaupifalco m. monogrammicus* (Temminck, 1824) small intestine; Côte d'Ivoire, Lamto, 9.02.1987, J. Mariaux (MNHG INVE 38486, INVE 69971). Prevalence: 50%.

DESCRIPTION

General: Trunk, spineless, elongate, cylindrical, female dilated posteriorly from about 500 to about 1500 above posterior end. Proboscis in 2 parts with constriction at insertion of proboscis receptacle, about 45% of distance from apex to proboscis base; anterior proboscis sub spherical. Proboscis armed with 34-36 rows 15-19 hooks. Anterior 2-3 hooks with large simple roots, thorns 20-25.5 (male) long; next 4-5 hooks transitional, having short roots with luniform- crescentic manubria, thorns 25.5- 44 (male) long; 9-11 spiniform hooks inserted on posterior part of proboscis posterior to constriction, thorns 20-40 (male) long. Neck spineless, well defined, shorter than broad. Proboscis receptacle double walled. Lemnisci tubular, inserted at base of neck, extend posteriorly beyond proboscis receptacle. Cerebral ganglion located at mid region of proboscis receptacle, just posterior to neck. Principal canals of lacunar system lateral, connected by transverse anastomoses.

Male: based on one intact specimen. Trunk 25 mm long, 1200 at widest part. Proboscis total length 605, greatest width 368; posterior part 335 long 315 wide. Neck



FIGS 6-13

Centrorhynchus mariauxi n. sp. (6) Holotype male, proboscis showing armature. (7) Holotype male, anterior, transitional and spiniform hooks. (8) Holotype male anterior end. (9) Female posterior end showing ojector. (10) Egg. (11) Holotype male, posterior end showing bursa. (12) Female posterior end lateral view. (13) Female posterior end dorsal view. Scale bars: 6, 9, 200 μ m; 7a, 35 μ m; 7b, 18 μ m; 8, 11, 1mm; 10, 15 μ m; 12, 13, 500 μ m.

300 long, 400 wide. Proboscis receptacle 1360 long, 235 wide; lemnisci 1273 long. Testes oval, tandem, not contiguous 1.1mm apart; anterior testis, 3.00 mm from anterior end of trunk, 529 long, 268 wide; posterior testis 556 long, 275 wide. Cement glands, 3, elongate, tubular, begin immediately posterior to end of posterior testis, 17.5 mm long; cement ducts elongated, 1800 long; Saeftigen's pouch 1250 long; entire male system occupying about 88% trunk length.

Female: based on anterior end one specimen, posterior end one specimen and longest piece. Trunk longer than 70mm, main trunk 500-600 wide, dilated posterior part 700-900 wide. Proboscis total length, 780 greatest width 390, posterior part 420 long 350 wide. Proboscis receptacle 1400-2200 long, 290-400 wide; lemnisci 1615 long. Genital apparatus, uterine bell to genital pore, 2000 long. Genital pore sub terminal. Eggs oval, external shell smooth, thick, 45 long, 22 wide.

COMMENTS: *Centrorhynchus mariauxi* n. sp. conforms to the diagnosis of the genus given by Golvan (1956, 1960). In his examination of the morphological characters available in the family for systematic analysis those of the proboscis armature, the number of longitudinal rows of hooks, the number of hooks in each row and the dimensions of the thorns and roots of the hooks were the most useful. Further he determined that the number of hooks per row was the most stable of these characters (Golvan 1956). Accordingly he subdivided the genus *Centrorhynchus* into 3 groups; those species with less than 30 longitudinal rows of hooks, those with 30-40 rows and those with more than 40 rows of hooks. With a proboscis armature of more than 30 rows *C. mariauxi* falls into Group 2 (Golvan 1956). The hook formula of 34-36 longitudinal rows of 15-19 hooks comprising 6-8 hooks with roots and 9-11 spiniform hooks distinguishes it from all other species in that group. Since then about 50 valid species of *Centrorhynchus* have been added to the genus including 20 species that have between 30 and 40 longitudinal rows of hooks.

Species known to occur in continental Africa that have a proboscis armature of 30-40 rows of hooks include *C. chabaudi*, from the Sudan and now the Côte d'Ivoire, *C. gendrei* from the Republic of Guinea, *C. milvus* from Egypt and Senegal, *C. clitorideus* (Meyer, 1931) from Egypt, *C. globocaudatus* from Egypt and West Africa, *C. polemati* Troncy, 1970 from Chad and *C. undulatus* Dollfus, 1951 from Morocco. Of these only *C. chabaudi* with 17-24, *C. milvus* with 18-21 and *C. undulatus* with 21 have a similar number of hooks per row. *C. chabaudi* can be distinguished by having 5-6 anterior hooks with longer thorns, 55-96 compared with 20-25 for *C. mariauxi* and small triangular roots on the anterior-most rows of spiniform hooks. The lemnisci of *C. mariauxi* are shorter and the testes smaller, further apart and more posterior than those of *C. chabaudi* (see Golvan, 1957 and this study). *C. milvus* differs from *C. mariauxi* in the hook pattern and proboscis length; 8-9 hooks with large roots, 5-6 transitional hooks and 5-6 spines on a longer proboscis, 0.8-1.19mm, compared with 2-3 large, 4-5 transitional and 9-11 spiniform hooks on a shorter proboscis, 0.61-0.77 (Ward, 1956; Dimitrova & Gibson 2005). The description of *C. undulatus* (females only) is brief. The only measurements are of the trunk, 15-18 mm, much shorter than for female *C. mariauxi* which are longer than 70 mm. Comparison of text and figures for *C. undulatus* suggests that the proboscis was about 1mm long with an armature of

21 hooks per row comprising 6 with large simple roots, thorns about 35-45 long, 3 transitional forms and 12 spiniform hooks (Dollfus, 1951). These differences seem sufficient to distinguish the two species. Comparative measurements for the west African species are given in table 2.

There are 12 known extra-limital species with 30-40 longitudinal rows of hooks: namely *C. bethaniae* George & Nadakal, 1987, *C. brygooi* Golvan, 1965, *C. conspectus* Van Cleave & Pratt, 1940, *C. crotophagicola* Schmidt & Neiland, 1966, *C. fukiensis*, Wang 1966, *C. guira* Lunaschi & Drago, 2010, *C. hagiangensis* Petrochenko & Phan, 1969, *C. kuntzi* Schmidt & Neiland, 1966, *C. madagascarensis* (Golvan, 1957), *C. nicaraguaensis* Schmidt & Neiland, 1966, *Centrorhynchus* cf. *polymorphus* Travassos, 1926, *C. undulatus* (Nitzsch in Giebel, 1886) (see Dollfus 1951; Golvan 1957, 1965, 1994; Hartwich 1956; Schmidt & Neiland 1966; Wang 1966, George & Nadakal 1987; Richardson & Nickol 1995; Dimitrova *et al.* 1997; Dimitrova & Gibson 2005; Lunaschi & Drago, 2010). None of the species listed, however, has a similar hook pattern to that of *C. mariauxi* with as few as 2-3 true hooks in each row.

The most similar extra-limital species is *C. conspectus* Van Cleave & Pratt, 1940 which has 28-38 rows of 16-19 hooks of which 4-5 have long simple roots and 12-15 are spiniform, but differs from *C. mariauxi* in having no transitional hooks (Richardson & Nickol 1995). Other species with a similar total number of proboscis hooks differ in numbers and sizes of each hook form. For example *C. nicaraguaensis* has 39 rows of 17 hooks but no transitional hooks; and *C. crotophagicola* has 32-35 rows of 15-17 hooks, but differs in having 8-9 hooks with long simple roots and 7-9 hooks with manubria (Schmidt & Neiland, 1966).

C. acanthotrias (Linstow, 1883) was assigned to *C. buteonis* by Meyer (1932, see Yamaguti 1963), listed as *Echinorhynchus* s. l. by Petrochenko (1985) and under genera incertae sedis by Yamaguti (1963) and Amin (1985). Never the less the species was noted by Petrochenko (1958) as 'obvious that it belongs to the Centrorhynchinae or even *Centrorhynchus*' and listed as a valid species by Golvan (1994). However the description is incomplete. Having 33-40 longitudinal rows of hooks the most anterior ones with straight roots, the median ones with bifurcated roots and the posterior ones with simple roots (Petrochenko 1958) *C. acanthotrias* may also be similar to *C. mariauxi*.

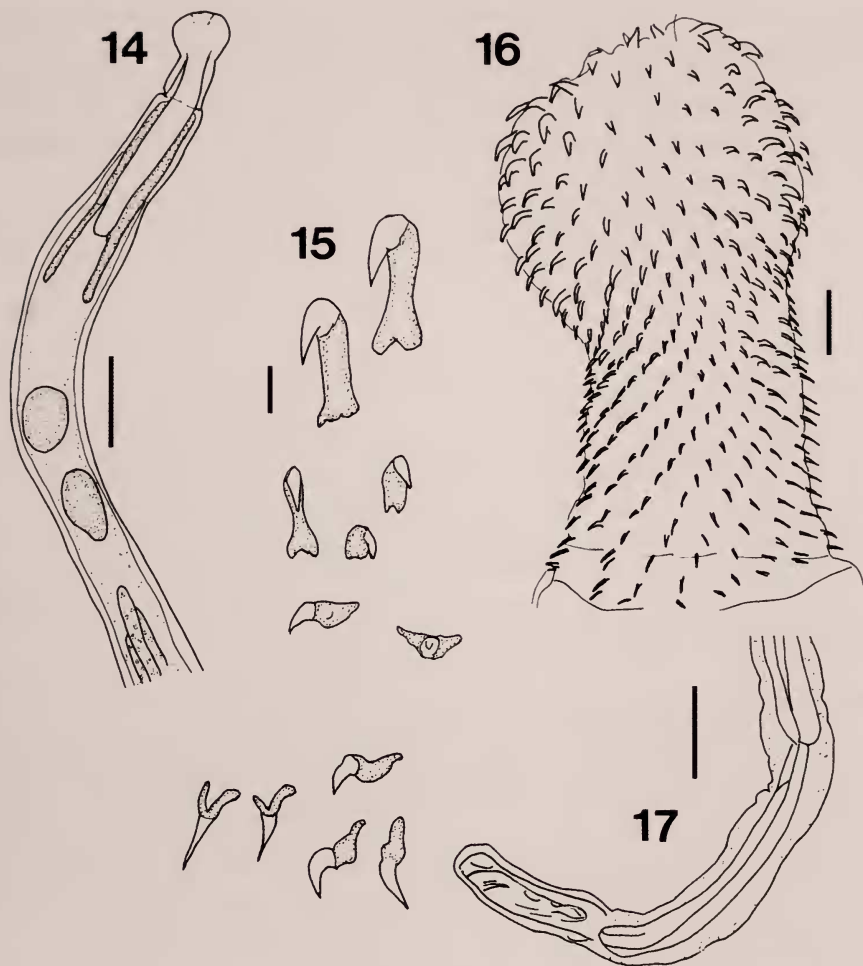
***Centrorhynchus halcyonicola* sp. n.**

Figs 14-17

MATERIAL EXAMINED: Holotype male from *Halcyon malimbica* (Shaw, 1811) small intestine; Côte d'Ivoire, Korhogo, 27.01.1987, J. Mariaux (MNHG INVE 38485). – 1 male, proboscis missing and 1 piece male from *H. malimbica* small intestine; Côte d'Ivoire, Lamto, 13.02.1987, J. Mariaux (MNHG INVE 38490). Prevalence: 40 %.

DESCRIPTION

General: Trunk, spineless, elongate, cylindrical. Proboscis in 2 parts with constriction at insertion of proboscis receptacle about half way between apex and proboscis base, anterior part sub cylindrical. Proboscis armed with 38-40 rows 14-17 hooks. Anterior 2-3 hooks with large simple roots, thorns 40-40.5 long; next 2-3 hooks transitional, having laterally directed manubria, thorns 25- 30 long; next 2 hooks tran -



FIGS 14-17

Centrorhynchus halcyonicola n. sp. (14) Holotype male, anterior end. (15) Holotype male, anterior transitional and spiniform hooks. (16) Holotype male, proboscis showing armature. (17) Holotype male, posterior end, bursa not everted. Scale bars: 14, 17, 500 μ m; 15, 20 μ m; 16, 80 μ m.

sitional with anteriorly directed manubria, thorns 40 long; 8-9 spiniform hooks inserted on posterior part of proboscis posterior to constriction, thorns 20-40 long. Neck spineless, not well defined. Proboscis receptacle double walled. Lemnisci tubular, inserted at base of neck, extend posteriorly beyond proboscis receptacle. Cerebral ganglion located at mid region of proboscis receptacle. Principal canals of lacunar system lateral, connected by transverse anastomoses.

Male: measurements taken from holotype. Trunk 20 mm long, 400 at widest part. Proboscis total length 640, greatest width 335; posterior part 335 long 268 wide.

Proboscis receptacle 1370 long 205 wide; lemnisci 1530 long. Testes oval, tandem, close together, not contiguous 150 apart; anterior testis, 1.8 mm from anterior end of trunk, 440 long, 340 wide; posterior testis 510 long, 290 wide. Cement glands, 3, elongate, tubular, begin posterior to posterior testis, 14 mm long; cement ducts elongated, 1955 long; Saeftigen's pouch and infolded bursa 1105 long; entire male system occupying about 85% trunk length.

COMMENTS: Although only male specimens were available for examination they were sufficiently distinctive to allow differentiation from all other species of *Centrorhynchus*. Despite the proboscis being slightly inverted in the only intact specimen the total length and hook formula could be calculated by observing the clearly visible inverted portion of the proboscis. *Centrorhynchus halcyonicola* sp. n. with a proboscis armature of 38-40 rows of 14-17 hooks falls within the same group as *C. mariauxi* as discussed above. Within that group *C. halcyonicola* is closest to *C. mariauxi* which has 34-36 rows of 15-20 hooks, 2-4 of which are hooks with large simple roots. The shapes of the roots of the transitional hooks of *C. halcyonicola*, however differ from those of *C. mariauxi* (figs 7, 15), the thorns of the anterior hooks are longer in *C. halcyonicola*, 40-40.5 compared with 20-25.5 and there are fewer spines. *Centrorhynchus halcyonicola* further differs from *C. mariauxi* in the size of the testes, larger in *C. halcyonicola*, and the proportions of the male system, the testes being placed more anteriorly and closer together in *C. halcyonicola*.

Similarly *C. halcyonicola* differs from all other species known from Africa as discussed above for *C. mariauxi*.

The proboscis hook morphology of *C. halcyonicola* is similar to that described for *C. alcuonis* (Müller, 1780) from *Asio otus*, Linnaeus, 1758, the long eared owl and *Strix aluco* Linnaeus, 1758, the tawny owl from Hungary by Dimitrova *et al.* (1995), particularly in regard to the shapes of the roots of the anterior and transitional hooks. The armature differs, however, in the number of rows of hooks, 38-40 compared with 28 and *C. alcuonis* further differs in the size of the proboscis receptacle, 1370 compared with 1450-1800 and the proportions of the male system (Dimitrova *et al.*, 1995). Both owl species also occur in North Africa supporting the possibility that there could be a link between the two species of *Centrorhynchus*.

DISCUSSION

The hosts and distribution of *C. chabaudi* have been extended in this study to include another West African country, the Republic of the Côte d'Ivoire, and accipitrid host, *A. badius*. The finding of two new species in the Côte d'Ivoire increases the number of species of *Centrorhynchus* known from West Africa from four, *C. chabaudi* from *A. badius* and *Gyps africanus*, *C. gendrei* from *K. monogrammicus* as *Asturina monogrammica*, *C. milvus* from *Milvus migrans* (Boddart, 1783) and *Lamprophis fuliginosus* (Boie, 1827) as *Boaedon fuliginosus* and *C. globocaudatus* from *Falco ardosiaceus* Viillot, 1823, to six. Five of these species can easily be distinguished by differences in the armature of the proboscis (Golvan, 1956, 1957, 1958; Dimitrova & Gibson, 2005) as well as host species. The sixth, *C. gendrei*, occurs in the same host, *K. monogrammicus*, as *C. mariauxi* but differs in proboscis armature and morphometrics (Golvan, 1958).

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